U.S. Department of Transportation
Federal Aviation Administration

# Advisory Circular

Subject: SPECIFICATION FOR RUNWAY AND TAXIWAY LIGHT FIXTURES

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Initiated by: AAS-200

AC No: 150/5345-46A
Change:

1. PURPOSE. This advisory circular (AC) contains specifications for light fixtures to be used on airport runways and taxiways.

2. EFFECTIVE DATE. Effective six months after the issue date of this advisory circular, only that equipment qualified in accordance with the specifications herein will be listed in AC 150/5345-1, Approved Airport Lighting Equipment.

3. CANCELLATION. AC 150/5345-46, Specification for Semiflush Airport Lights, dated July 11, 1975; and AC 150/5345-48, Specification for Runway and Taxiway Edge Lights, dated August 1, 1975, are cancelled.

4. PRINCIPAL CHANGES. This AC has been completely rewritten to incorporate elevated lights and inpavement lights into one specification. The following principal changes have also been incorporated:

a. Removal of some detail requirements for light fixture design,

b. Use of a tabular method of specifying photometric performance,

c. Reorientation of the inpavement edge light photometrics to conform with those of the elevated edge lights,

d. Addition of three new inpavement taxiway lights for Category III operations,

e. Addition of a new flashing elevated taxiway light for holding position marking,

f. Addition of a classification for inpavement lights which describes the manner of installation,

g. Addition of a classification which describes the power source required,

h. Addition of environmental testing for elevated lights, and

i. Elimination of the low intensity taxiway edge light.

# SPECIFICATION FOR RUNWAY AND TAXIWAY LIGHT FIXTURES

## 1. SCOPE AND CLASSIFICATION.

1.1 Scope. This specification covers the requirements for light fixtures for use on airport runways and taxiways.

1.2 Classification. The following light fixtures are covered by this specification.

1.2.1 Types.

a. Runway Inpavement Lights.

| Type | Use | Light Direction and Colors |
|---|---|---|
| L-850A | Runway centerline | Bidirectional: white-white, white-red<br>Unidirectional: white, red |
| L-850B | Runway touchdown zone; medium intensity approach lighting system | Unidirectional: white |
| L-850C | Runway edge | Bidirectional: white-white, white-yellow white-red, yellow-red, yellow-green, white-green |
| L-850D | Runway threshold/end | Bidirectional: green-red, red-red<br>Unidirectional: green |
| L-850E | Medium intensity approach lighting system, threshold | Unidirectional: green |

b. Taxiway Inpavement Lights.

| Type | Use | Light Direction and Colors |
|---|---|---|
| L-852A | Taxiway centerline, straight sections; caution bar (except Cat. III) | Bidirectional (narrow beam): green-green, green-yellow<br>Unidirectional (narrow beam): green, yellow |
| L-852B | Taxiway centerline, curved sections; (except Cat. III) | Bidirectional (wide beam): green-green yellow-yellow<br>Unidirectional (wide beam): green, yellow |
| L-852C | Taxiway centerline, straight sections; caution bar (Cat. III) | Bidirectional (narrow beam): green-green, green-yellow<br>Unidirectional (narrow beam): green, yellow |

| Type | Use | Light Direction and Colors |
|---|---|---|
| L-852D | Taxiway centerline, curved sections (Cat. III) | Bidirectional (wide beam): green-green, yellow-yellow<br>Unidirectional (wide beam): green, yellow |
| L-852E | Taxiway intersections (except Cat. III) | Omnidirectional: yellow |
| L-852F | Taxiway intersections (Cat. III) | Omnidirectional: yellow |

c. Elevated Lights.

| Type | Use | Light Direction and Colors |
|---|---|---|
| L-860 | Runway edge, VFR runways | Omnidirectional: white<br>Bidirectional: white-red, white-green |
| L-860E | Runway threshold/end, VFR runways | Bidirectional: red-green, red-red<br>Unidirectional: green |
| L-861 | Runway edge, non-precision IFR runways | Omnidirectional: white<br>Bidirectional: white-yellow, white-red, yellow-red, white-green |
| L-861E | Runway threshold/end, non-precision IFR runways | Bidirectional: red-green, red-red<br>Unidirectional: green |
| L-861SE | Runway threshold/end, non-precision IFR runways | Bidirectional: red-green<br>Unidirectional: green |
| L-861T | Taxiway edge | Omnidirectional: blue |
| L-862 | Runway edge, precision IFR runways | Bidirectional: white-white, white-yellow, white-red, yellow-red, white-green |
| L-862E | Runway threshold/end, precision IFR runways | Bidirectional: red-green, red-red<br>Unidirectional: green |
| L-804 | Holding position edge | Unidirectional: yellow; flashing |

1.2.2 Class. The class designation applies only to inpavement fixtures.

Class 1 Direct-mounted fixtures

Class 2 Base-mounted fixtures

1.2.3 Mode. The mode designation describes the type of electrical power supply required for the fixture.

Mode 1 Constant current fixture, supplied by either 6.6 or 20 Amperes

Mode 2 Constant voltage fixture, supplied by 120 Volts ac

1.2.4 Options. The manufacturer may provide the following optional features. These options must meet the requirements of 3.11.

Option 1 Lamp By-Pass (in-pavement lights)

Option 2 Instruction Manual

Option 3 Shields (elevated lights)

Option 4 Mounting Hardware (elevated lights)

2. APPLICABLE DOCUMENTS.

2.1 General. The following documents, of the issue in effect on the date of application for qualification, are applicable to the extent specified in this AC.

2.2 Federal Aviation Administration (FAA) Advisory Circulars.

AC 150/5345-1 Approved Airport Lighting Equipment

AC 150/5345-10 Specification L-828, Constant Current Regulators

AC 150/5345-26 Specification for L-823 Plug and Receptacle, Cable Connectors

AC 150/5345-42 Specification for Airport Light Base and Transformer Housings, Junction Boxes, and Accessories

AC 150/5345-47 Isolation Transformers for Airport Lighting Systems.

2.3 Federal Publications.

2.3.1 Federal Standard.

FED-STD-595 Colors

2.3.2 Federal Specification.

QQ-P-416 Plating, Cadmium (Electrodeposited)

2.4 Military Publications.

2.4.1 Military Standards.

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes

MIL-STD-810 Environmental Test Methods and Engineering Guidelines

2.4.2 Military Specifications.

| | |
|---|---|
| MIL-C-7989 | Covers, Light-Transmitting, for Aeronautical Lights, General Specification for |
| MIL-C-13924 | Coating, Oxide, Black, for Ferrous Metals |
| MIL-C-25050 | Color, Aeronautical Lights and Lighting Equipment, General Requirements for |

2.5 American National Standards.

| | |
|---|---|
| ANSI B1.1 | Unified Inch Screw Threads (UN and UNR Thread Form) |
| ANSI B46.1 | Surface Texture (Surface Roughness, Waviness, and Lay) |

2.6 American Society of Testing and Materials (ASTM) Standard.

| | |
|---|---|
| B-633 | Electrodeposited Coatings of Zinc on Iron and Steel, Specification for |

2.7 Illuminating Engineering Society (IES) Publication.

| | |
|---|---|
| IES LM-35 | IES Approved Method for Photometric Testing of Floodlights Using Incandescent Filament or Discharge Lamps |
| | IES Guide for Calculating the Effective Intensity of Flashing Signal Lights, published in Illuminating Engineering, Volume LIX, Page 747 (November 1964) |

(FAA advisory circulars may be obtained from the Department of Transportation, Publications Section, M-494.3, Washington, DC 20590.)

(Federal standards and specifications may be obained from General Services Administration offices in Atlanta, GA; Boston, MA; Chicago, IL; Denver, CO; Fort Worth, TX; Houston, TX; Kansas City, MO; Los Angeles, CA; New York, NY; Philadelphia, PA; San Francisco, CA; Seattle, WA; and Washington, DC.)

(Military publications may be obtained from the Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120, Attention: Code CDS.)

(American National Standards may be obtained from the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

(ASTM standards may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(IES publications may be obtained from the Illuminating Engineering Society, 345 E. 47th Street, New York, NY 10017.)

3. REQUIREMENTS.

3.1 General. This specification covers the requirements for inpavement and elevated light fixtures used on airport runways and taxiways.

3.2 Environmental Requirements. The light fixtures shall achieve specified performance under the following environmental conditions.

a. Temperature. Exposure to any temperature from -55 to +55° C.

b. Temperature shock. Exposure of the hot light fixture to cold water spray.

c. Salt fog. Exposure to a corrosive salt atmosphere.

d. Wind. Exposure to wind velocities of 350 mph (560 kph) for all L-861 and L-862 fixtures, and 150 mph (240 kph) for all other elevated fixtures.

e. Rain. Exposure to rain, snow, ice, and standing water.

f. Solar radiation. Exposure to solar radiation.

3.3 Photometric Requirements. The photometric performance of the fixtures is defined in Tables 1, 2, and 3. The beam coverage angles in the table define the size of an ellipse or rectangle (for this discussion, it is assumed to be an ellipse. The same guidelines apply to rectangles.) The light intensity inside the ellipse, when averaged as described in 4.3, shall equal or exceed the intensity specified in the table. Additionally, the intensity shall be at least one-half the specified value everywhere inside the ellipse. For some fixtures, a 10 percent ellipse is also defined. The two ellipses are concentric; i.e., the main beam ellipse is exactly centered in the 10 percent ellipse. At every point on the 10 percent ellipse the light intensity must be at least 10 percent of the specified value. For inpavement lights, part of the 10 percent ellipse may lie below grade; this area may be disregarded. The light color shall match the aviation colors defined in MIL-C-25050.

3.4 Dimensional Requirements. The light fixtures described in this specification may be installed directly in the ground or pavement, or they may be mounted atop a standard FAA light base and transformer housing (specified in AC 150/5345-42.) Dimensional requirements for both methods of mounting, and other essential dimensions, are given below.

3.4.1 Inpavement Lights. The slope of the top surface of the light fixture, which protrudes above finish grade, shall be no more than 20° (recesses excepted), and the total height above grade for the fixture shall be no more than 1 inch (25 mm) for L-850 C, D, and E, and L-852 E and F; all other fixtures shall be less than 1/2 inch (12 mm) above grade.

3.4.1.1 Class 1 (Direct Mounted). When not installed on an L-868 base, the inpavement light fixture is typically installed in a recess cut in the pavement, and secured by an adhesive compound poured around the lights. The power conductors are run to the light fixture through a saw kerf in the pavement. The light fixture shall be designed to maximize adhesion by the securing compound, and to resist rotation and uplift. All optical components and electrical components (except those

Table 1. Photometric requirements for inpavement lights.

| Type | Minimum beam coverage (degrees)(a) | | | | Intensity (candelas) (b) | | | |
|---|---|---|---|---|---|---|---|---|
| | Main beam (c) | | 10 percent (d) | | | | | |
| | H | V | H | V | White | Yellow | Green | Red |
| L-850A | ± 5 | 0.2 to 9 | ±7 | -4 to 13 | 5000 | | | 750 |
| L-850B | -1 to 9 | 2 to 9 | -3 to 11 | -0.5 to 11.5 | 5000 | | | |
| L-850C | -2 to 9 | 0.2 to 7 | -4 to 11 | -2.5 to 9.5 | 10000 | 5000 | | 1500 |
| L-850D | -2 to 9 | 1 to 10 | | | | | 3300 | |
| | ± 6 | 0.2 to 4.7 | ±7.5 | -2.5 to 7.5 | | | | 2500 |
| L-850E | ± 6 | 1 to 9 | | | | | 5000 | |
| L-852A | ± 10 | 1 to 4 | ±16 | 0.5 to 10 | | 20 | 20 | |
| L-852B | ± 30 | 1 to 4 | ±30 | 0.5 to 10 | | 20 | 20 | |
| L-852C | ± 3.5 | 1 to 8 | ±4.5 | 0 to 13 | | 200 | 200 | |
| L-852D | ± 30 | 1 to 10 | ±30 | 0 to 15 | | 100 | 100 | |
| L-852E | 360 | 1 to 8 | | | | 50(e) | | |
| L-852F | 360 | 1 to 10 | | | | 200(e) | | |

(a) For runway fixtures, beam coverages given are for the extremities of an ellipse. For taxiway fixtures, beam coverages are the extremities of a rectangle.

(b) Values given represent minimum average intensity except for L-850E, where minimum intensity is given. Reference 4.3 for method of calculating average beam intensities.

(c) In addition to the average intensity requirement, all points within the main beam must be at least fifty percent of the specified average intensity.

(d) The intensity on this ellipse must be at least 10 percent of the specified minimum average intensity. The main beam and 10 percent ellipses are concentric; that is, the main beam ellipse lies exactly in the center of the 10 percent ellipse. For inpavement lights, any part of the ellipse that falls below grade may be disregarded.

(e) Twenty-five percent reduction of candela intensity allowed at structural ribs.

Table 2. Photometric requirements for directional elevated lights.

| Type | Minimum beam coverage (degrees)(a) | | | | Intensity (candelas)(b) | | | |
|---|---|---|---|---|---|---|---|---|
| | Main beam | | 10 percent (e) | | | | | |
| | H | V | H | V | White | Yellow | Green | Red |
| L-862(c) | -2 to 9 | 0 to 7 | -4 to 11 | -2.5 to 9.5 | 10,000 | 5,000 | | |
| L-862E | ± 6 | 0.2 to 4.7 | ± 7.5 | -2.5 to 7.5 | | | | 2500 |
| | -2 to 9 | 1 to 10 | | | | | 4,000 | |
| L-861E | ± 1.5(d) | 3.5 to 5.5 | | | | | 300 | |
| | ± 3 (d) | 1.5 to 7.5 | | | | | 180 | |
| | ± 5 | 0 to 7 | | | | | 90 | 10 |
| L-861SE | ± 15 | 2 to 10 | | | | | 600 | |
| L-804 | ± 8 | ± 8 | | | | 600 | | |

(a) Beam coverages are given for the extremities of an ellipse.

(b) Values given represent minimum average intensity. See 4.3.

(c) Minimum of 50 candelas required omnidirectionally for all vertical angles to 15 degrees.

(d) Beam coverage is given for the extremities of a rectangle

(e) See note (c) and (d) of table 1.

Table 3. Photometric requirements for omnidirectional elevated lights.

| Type | Color | Intensity (a) 2-10° (min) | 2-10° (avg) | 10-15° (min) |
|---|---|---|---|---|
| L-861 | White | 75 | 125 | 40 |
| | Yellow | 37 | 67 | 20 |
| L-860 | White | 15 | 25 | 10 |
| L-860E | Green | 10 | 15 | 5 |
| | Red | 3 | 5 | 1 |
| L-861T | Blue | 2 (b) | | |

(a) Angles measured in vertical plane

(b) L-861T coverage is 2 candelas from 0 to 6 degrees vertically, 0.2 candela at all other vertical angles.

used to carry the incoming power) shall be removable for servicing without breaking the glue bond. Any associated shallow base or other installation accessories shall be able to withstand the specified loading and environmental stresses. The manufacturer shall specify in the installation instructions the shape and dimensions of the recess required for installation of the light. If installation bolts are used, they shall be furnished with their companion lockwashers.

3.4.1.2 Class 2 (Base Mounted). Interface details and dimensions of L-868 bases are shown in AC 150/5345-42. Critical interface areas of the light fixture are the outer diameter, top flange, bolt holes, and throat projection. For L-850 A and B, the outer diameter of the light fixture shall be 11.94 inches (303.3 mm) ±0.05 inch (1.3 mm) and shall mate with a size B L-868 base. For L-850 C, D, and E, the fixture shall have an outside diameter of 17.25 inches (438.1 mm) ±0.09 inch (2.3 mm), and shall mate with an L-868 size C base (alternatively, the C, D, and E may use the same dimensions as the A and B). The light fixture shall have a projection that extends at least 1/4 inch (6 mm) down through the top flange of the L-868 base. The diameter of this projection shall be 0.06 inch +0.00,-0.01 inch (1.5 mm +0.0,-0.25 mm) less than the nominal diameter of the top flange cutout. Semiflush lights shall be designed to mount on an L-868 base whose top surface is 3/4 inch below grade; flush lights may be designed to fit atop a base placed up to 1-1/4 inch below grade (L-850 C, D, and E may use either criteria). If the installation of the light requires grooves or recesses in the surrounding pavement, the manufacturer shall describe the dimensions of these recesses and how they are to be drained. The fixture shall be designed to be secured by six mounting bolts, supplied with the base and described in AC 150/5345-42. The fixture bolt-hole configuration shall match the Type L-868 base which it is sized to fit. In addition, the axis between one pair of bolt holes must be perpendicular to the direction of the runway centerline.

3.4.2 Elevated Lights. The installed height of elevated light fixtures (except L-804) shall not exceed 14 inches (350 mm). This height may be increased to 30 inches (750 mm) for applications in snow areas. When the purchaser specifies that a mounting system be provided, it shall conform with the requirements below.

3.4.2.1 Yield Device. Each elevated light fixture shall have a yield point near where the light attaches to the base plate or mounting stake. The yield point shall withstand a bending moment of 150 foot-pounds (204 N·m) without failure, but shall separate cleanly from the mounting system before the bending moment reaches 500 foot-pounds (678 N·m). However, L-860 fixtures may bend instead of separating. The fixture shall not sway more than 1 inch from vertical under the specified wind loading. The yield point shall be no more than 1½ inch (37 mm) above grade, and shall give way before any other part of the fixture is damaged. If the yield device uses a threaded connection to the base plate or stake, it should have a male external thread with either 2"-11½ NPT or NPS threads, or 1½"-12 UNF threads. If threaded, the yield device shall have a faceted surface, i.e., hexagonal section, below the yield point to facilitate removal. The yield device should be easily replaceable after breakage. For Mode 1 (series-powered) fixtures, the yield device shall be hollow to allow a receptacle and socket to be positioned internally as described in 3.7.2. If the yield device is of the "pop-out" variety that may be reassembled after separation, the manufacturer shall provide test data demonstrating the number of times the device may be separated before falling outside of the acceptable yield device performance band. This information shall be included in the instruction manual. Nonmetallic yield devices shall provide specified performance over the full temperature range.

3.4.2.2 Base Mounting. When the elevated light fixture is mounted on an L-867 base, it is mated with a base plate whose diameter and bolt-hole circle correspond to one of the L-867 base sizes. The base plate shall be designed to receive the frangible device provided; typically, this is a straight female thread. A neoprene gasket (or equivalent) shall be provided with the base plate to form a watertight seal between the base plate and the L-867 light base. This gasket shall have a minimum thickness of 1/8 inch (3 mm) and shall fit the bolt circle of the L-867 light base flange. When the base plate is bolted to an L-867 light base, it shall withstand a static load of 2,500 pounds (1125 kg) without damage or permanent deformation.

3.4.2.3 Stake Mounting. When not installed on a base, the elevated light fixture shall be mated with a stake made of 2x2x3/16 inch steel angle. The stake shall have a fitting attached at the top to receive the yield device. The length of the stake and fitting shall be 30 inches (750 mm). Alternate staking methods may be used if it can be demonstrated that equal support and durability is provided.

3.4.3 L-804 Holding Position Light. This fixture consists of two lights, mounted side by side in the same housing, which flash alternately to help identify taxiway holding position lines. The two lights shall each have a cover or source size of at least 8 inches (200 mm) in diameter. These two lights shall be mounted in a housing that rigidly positions the lights, and shields them from view from the back, top, or sides. The installed fixture shall be 30 inches (750 mm) tall, and shall be designed for installation on a concrete pad or stakes. Provision for higher mounting in snow areas may be provided. Adjustments shall be provided to allow the lights to be aimed at any vertical angle from 0 to 20 degrees in elevation. All components required for installation shall be supplied, and all mounting legs shall have yield devices as described in 3.4.2.1.

3.5 Structural Integrity. The inpavement light fixtures shall withstand the mechanical stresses detailed below without damage.

3.5.1 Vibration. Inpavement light assemblies shall withstand vibration along any axis; they shall withstand an inertial load of up to 15 Gs when vibrated at frequencies between 20 and 2000 Hz. The lamp filament shall withstand an inertial load of 3 Gs when vibrated between 20 and 2000 Hz.

3.5.2 Static Load. When installed according to the manufacturer's recommendations, the light assembly shall withstand a static loading (in pounds) of 450 times the top area of the light fixture (in square inches) distributed uniformly over the top surface.

3.5.3 Shear Load. The light assembly shall withstand a shear load of 3,000 pounds (1360 kg) applied to the top of the light in any direction parallel to the mounting surface.

3.5.4 Hydraulic Impact. The top of the light assembly (all surfaces exposed when properly installed) shall withstand a momentary hydraulic pressure of 200 psi (1380 kPa).

3.5.5 Mechanical Impact. For L-850 lights, the light assembly shall withstand the repeated impact of a steel ball with 30 foot-pounds (40 J) of energy.

3.5.6 Leakage Resistance. The subassembly containing the optical components, including the lamp, shall be resistant to water leakage or infiltration from above or below the light fixture. Specifically, the optical assembly shall withstand an internal pressure of 20 psi (138 kPa) without leakage.

3.5.7 Surface Temperature. The light fixture shall be designed so that the surface temperature will not exceed 160° C when the fixture is operating at maximum intensity while covered by the wheel of a heavy ground vehicle or aircraft for a period of 10 minutes.

3.6 Drainage.

3.6.1 Elevated Lights. Elevated light fixtures shall be constructed so that a tight seal is formed between the components. A gasket shall be used between the fixture cover and body to improve the seal. The fixture shall be constructed so that any water developed internally will drain down past the yield point. The L-804 fixture may use a drain hole rather than drain down the mounting legs. The design should not allow water build-up around the yield point.

3.6.2 Inpavement Lights. Class 2 light fixtures shall be designed for either a "dry" or "wet" system. A "wet" system requires the light installer to supply sufficient drainage in the base/conduit system to allow the light fixture to drain into the base. In a "dry" system, no water drains from above the light into the base. The optical assembly shall be sealed from above and below. "Dry" systems may use an "O" ring (supplied with the base) in the mounting flange of the base to improve sealing; gaskets shall not be used at this interface. For "wet" systems, water from the channel in front of the optical window and any associated recessed areas may be drained into the base to prevent water from obstructing the light beam. If part of the optical window is below grade, the light fixture shall emit at least 50 percent of the specified light output when that portion of the window below grade is blocked. For designs that have more than half the window below grade, the fixture shall emit 50 percent intensity with the lower half of the window area blocked.

3.7 Electrical Requirements. All L-862 and inpavement light fixtures shall use a Mode 1 (constant current) power supply of either 6.6 or 20 amperes. All L-860 light fixtures shall use a Mode 2 (constant voltage) power supply; the L-861 and L-804 light fixtures may be either Mode 1 or Mode 2. Mode 1 fixtures shall be designed to interface with an isolation transformer (specified in AC 150/5345-47), and shall be compatible with all approved L-828 regulators. The names and addresses of approved regulator manufacturers may be found in AC 150/5345-1. Upon request they will provide oscilliscope photographs of the regulator's output waveform.

3.7.1 Inpavement Lights. The light fixture shall have a minimum insulation resistance of 50 megohms lead-to-case when dry or while soaking in salt water. Leads shall be stranded copper insulated with material suitable for the electrical and temperature requirements, and shall be at least 18 inches (460 mm) long. Leads

for Class 2 fixtures shall be terminated with an L-823 plug (specified in AC 150/5345-26) to mate with the socket on the secondary lead of an isolating transformer. Leads for Class 1 light fixtures shall be sealed at the entry to the fixture and shall have the ends ready for splicing. Moisture shall not wick into the fixture through the leads.

3.7.2 Elevated Lights. A lead assembly of appropriate length shall be supplied to connect the lamp socket to the power source. Two stranded copper conductors shall be provided, with adequate current capacity and insulation for the operating environment. A clamp or similar device shall prevent any strain or tugging on the lead from being transmitted to the lamp socket. All wiring shall be run internally; L-860 fixtures may use external wiring if desired. At the yield point on elevated lights with frangible or "pop-out" devices, the electrical circuit shall have a means of disconnecting (such as a plug and receptacle) to break the electrical circuit and allow the light fixture to separate cleanly.

3.7.2.1 Mode 1 (Series-Powered) Fixtures. On Mode 1 fixtures, the receptacle leads shall be terminated in an L-823 plug. This plug mates with the receptacle on the secondary lead of an isolating transformer. The mounting system (either base plate or stake) shall firmly position this isolating transformer receptacle so its mating face is at the yield point, and so it will not be dislodged by separation from the plug. Drainage shall be provided around the receptacle retainer to prevent water buildup around the yield point (as required in 3.6.1.)

3.7.2.2 Mode 2 (Parallel-Powered) Fixtures. The lead from the lamp socket to the underground power cable shall be provided with a disconnect device at the yield point of the fixture. For L-860 fixtures with flexible mounting systems or external wiring, the disconnect device may be at any convenient point. The lead must be secured so that no strain is placed on the primary power cable when the disconnect device is pulled apart by the separation at the yield point of the light fixture. When the disconnect device is separated, the energized leads from the power cable must not be exposed.

3.7.3 L-804 Holding Position Fixture. The holding position fixture may be designed to accept a Mode 1 or Mode 2 power supply. The power input cable shall have sufficient length to reach at least 6 inches (150 mm) below grade when installed, and shall have provision for strain relief. The power input cable shall terminate in a plug; for Mode 1 circuits, this shall be an L-823 plug. Plugs and receptacles for Mode 2 circuits shall be of good quality, weather-proof and suitable for direct burial. If a standard L-823 plug is not used, the mating receptacle for the plug shall be provided for field installation.

3.7.3.1 Flasher. The two lights in the holding position fixture shall be alternately illuminated 50 to 60 times a minute. The flashing mechanism used to switch the two lights shall maintain the flash rate within tolerance under the specified environmental conditions. If required, filters shall be included to suppress EMI. The illuminated period of each flash shall not be less than 1/2 nor more than 2/3 of the total cycle.

3.7.3.2 Control. One of two methods may be used to control the brightness of the holding position light. One method is to allow the lamp intensity to vary with the current delivered to the fixture via a series circuit. Depending on the regulator

used to energize the circuit, this current may vary from 4.8 to 6.6 amps, from 2.8 to 6.6 amps, or from 8.5 to 20 amps. The other method is to use a photocell to switch the lamps to 30 percent intensity at low light levels. The photocell shall turn the fixture to high intensity when the light falling on it reaches 50 to 60 footcandles, and low intensity when the light falling on it reaches 25 to 35 footcandles. A time delay shall be incorporated to prevent mode switching due to transient light conditions.

3.8 Optical Requirements. The internal components of the optical assembly shall be protected from dirt, corrosion, humidity, or other environmental factors that might degrade performance. Reflectors shall have a finish of high specular reflectivity. All light transmitting surfaces shall conform to MIL-C-7989, Class B, C, or D. Covers shall resist abrasion or other damage from sandblasting, sunlight, and chemicals in the air. A durable label with replacement lamp identification data shall be placed in the fixture near the lamp. Lamps for the Type L-850, L-862, L-861SE, and the L-852 E and F lights shall have a minimum rated life of 500 hours; all others shall have at least 1,000 hours.

3.9 Maintenance. All interior components of the light fixture must be easily removable for cleaning or replacement. The optical components shall be keyed so that they may not be reassembled incorrectly. The lamp shall be accurately and firmly positioned at the proper focal point. Any interior lenses or filters shall be securely positioned. After reassembly, all components shall be properly aligned, original water resistance shall be restored, and the required photometrics shall be produced. No special tools shall be required for maintenance. Directional light fixtures shall be marked to indicate the correct orientation with respect to the runway centerline. Elevated fixtures with exposed metal parts which might present a shock hazard shall be grounded. The fixture shall be marked with the manufacturer's name and with the fixture type. For L-861 and L-862 fixtures, at least 4° adjustment shall be provided in all directions to allow leveling of the fixture after installation. For inpavement lights, a fitting may be supplied to allow pressurization of the sealed optical assembly. The fitting may be permanent, or it may be replaced by a plug for installation. This fitting will be used to test the seals after field maintenance. On the top of inpavement lights, pry slots, threaded holes, or other means shall be supplied to assist in removing stubborn fixtures adhering to the mating surfaces.

3.10 Materials and Finish. All components shall be suitable for the intended purpose and adequately protected against corrosion. The components shall have adequate capacity and shall not be operated in excess of the component manufacturer's recommended rating.

3.10.1 Inpavement Lights.

3.10.1.1 Hardware. All bolts, studs, nuts, lockwashers, and other similar fasteners used in the light fixture shall be fabricated from either 18-8, 410, or 416 stainless steel, passivated and free from discoloration. Bolts or screws made of 410 or 416 stainless steel shall be given a black oxide finish in accordance with MIL-C-13924, Class 3. All screw threads shall be Class 2 or Class 3 in accordance with ANSI B1.1. This paragraph does not apply to current-carrying components.

3.10.1.2 Finish. All surfaces of the finished top assembly shall be smooth, without burrs or sharp edges. Any "O" ring grooves shall have a surface finish of 64 rms maximum as defined in ANSI B46.1. In addition, all edges above the pavement shall be rounded to not less than 1/16 inch (1.59 mm) radius. The surface on the light fixture that mates with the base flange shall have a smooth finish to provide good load transfer and sealing.

3.10.2 Elevated Lights.

3.10.2.1 Protection of Metals. Ferrous metals shall be galvanized or given other equal corrosion protection. Copper bearing hardware in contact with aluminum shall be plated with cadmium, nickel, or zinc.

3.10.2.2 Finishes. For nonoptical surfaces, exterior finish shall match color No. 13538, Aviation Yellow, Table V of Federal Standard No. 595.

3.10.2.2.1 Metal Parts. Metal parts shall be protected by at least one prime coat (or other suitable preparatory painting process) and one finish coat. Paint for the finish coat shall be a high quality paint suitable for the drying process used. Paint for the prime coat shall be suitable for the metal treatment involved.

3.10.2.2.2 Nonmetallic Parts. Nonmetallic parts shall have the color integral to the material or shall be protected by a finish coat of paint suitable for the drying process and compatible with the material. The finish shall be able to endure the environmental stresses in 3.2 for a suitable period.

3.11 Optional Items.

3.11.1 Option 1 - Lamp By-Pass. For inpavement lights, an electrical bypass device may be available for specification by the purchaser. This device shall close an auxiliary circuit around the lamp within 15 seconds after failure of the lamp. A film disc cutout or other suitable device may be used for this function. A suitable holder and bypass wiring shall be furnished for this device.

3.11.2 Option 2 - Instruction Manual. An instruction manual shall contain at least the following information:

a. Diagram showing layout of parts and wiring;

b. Complete parts list with the names and addresses of the component suppliers and their part numbers;

c. Assembly and installation instructions, including dimensions of any pavement cuts, recommended torques, and special mounting requirements; and

d. Maintenance instructions, including durability information on "pop-out" yield devices for elevated lights.

3.11.3 Option 3 - Shields. For elevated lights, the manufacturer may provide shields to eliminate unneeded light. These shields are attached after the fixture is in place, and are oriented according to the needs of a particular installation.

3.11.4 Option 4 - Mounting Hardware. The manufacturer shall provide the type of mounting system specified by the user of the elevated lights. The user may specify a base plate, stake, or may purchase the light without mounting hardware. The user may also order an elongated column for snow areas. If a mounting system is provided, it shall meet the requirements of 3.4.2 and subparagraphs.

4. QUALIFICATION REQUIREMENTS.

4.1 Qualification Request. Procedures for obtaining qualification approval are contained in the latest edition of AC 150/5345-1, Approved Airport Lighting Equipment.

4.2 General. Each type, class, and style of light fixture to be approved shall be tested. Only one set of mechanical tests is required for each light fixture structural design.

4.3 Photometric Testing. The optical performance of each light fixture shall be determined by photometric measurements.

4.3.1 Procedures. Before testing, photometric test equipment shall be calibrated in accordance with paragraph 6 of IES LM-35. The photometric axes are established in relation to a properly installed fixture; the horizontal axis passes through the center of the fixture and is parallel to the runway centerline (for inpavement lights it is at grade), and the vertical axis runs through the center of the fixture and is perpendicular to the ground plane. Horizontal angles toward the runway centerline are positive. The fixtures shall be operated for at least 15 minutes before taking measurements. Photometric measurements shall be taken with at least five random production-run lamps. For fixtures with a 10 percent ellipse specified, at least 8 points shall be measured on this ellipse. The method of measurement required to demonstrate compliance with the specification is given below.

4.3.1.1 Narrow-Beam Fixtures. For fixtures with a horizontal main beam width specified less than ±10 degrees, intensities shall be measured along the horizontal and vertical axes at intervals of 1 degree--a minimum of ten readings on each axis shall be taken. The average value of each axis, as computed in 4.3.3, shall meet the minimum average intensity requirements. For the L-850E, each reading shall equal or exceed the minimum intensity.

4.3.1.2 Wide-Beam Fixtures. For fixtures with a horizontal beam width greater than 20 degrees but less than 180 degrees, horizontal "cuts" shall be taken to measure the light intensity at each one degree interval throughout the required vertical beam spread. At least 10 readings shall be taken at each horizontal "cut." The results of these horizontal "cuts" shall be averaged collectively, according to 4.3.3, and this average shall meet the minimum average intensity requirements. The full measurements shall be taken with at least one lamp, and the other four may be submitted with a single representative horizontal "cut"; the FAA may, however, require additional data with other lamps to ensure compliance.

4.3.1.3 Omnidirectional Fixtures. For fixtures with a specified horizontal beam width greater than 180 degrees, the vertical beam spread shall be measured at least every 30 degrees of the horizontal beam width. Each reading shall meet the

minimum intensity requirement, and the average of each vertical "cut" shall meet the minimum average intensity requirement. For inpavement lights, a 25 percent intensity reduction may occur at structural ribs.

4.3.2 Chromaticity. Each fixture shall be tested with each type of filter, lamp, and optical system to be used in the fixture to ensure that it meets the intensity and chromaticity requirements. Alternatively, chromaticity and transmissivity for color filters may be measured, while at the operating temperature of the light fixture, and used to calculate color photometric output from measurements taken in white light.

4.3.3 Calculations. When computing the average intensity for a test beam, the largest value used may be no more than three times the smallest axial value for that axis. Test data sheets submitted shall show the original data values before averaging.

4.3.4 Special Conditions - Inpavement Lights. For inpavement lights, photometric tests must follow the shock and hydraulic impact tests to determine if the lamp filament has sustained any damage. If an inpavement light is designed so that any portion of the exterior lens or prism is below pavement level, that portion shall be obscured by opaque tape, but no more than half the lens area shall be blocked. The resulting intensity distribution, in the applicable color, shall be no less than 50 percent of that required in appendix 1. The center of the light beam may be shifted $\pm$0.5 degree vertically, and $\pm$1.0 degree horizontally to meet the photometric curve. Type L-852B and D fixtures may be shifted $\pm$2.5 degrees horizontally.

4.3.5 Special Conditions - Elevated Lights. The resultant isocandela curves may be shifted a maximum of one degree horizontally or vertically to achieve compliance with the specified photometric curve. For L-804 fixtures using incandescent lamps, the flasher shall be disabled, and each light measured independently while steady-burning. For discharge lamps, the intensity shall be computed according to IES procedure referenced in 2.7.

4.4 Load Test. A static load test shall be performed on the complete inpavement light fixture (and a shallow base or L-868 facsimile), and on the elevated light base plate. The base plate shall be mated to an L-867 base (or equivalent) for testing. The test load shall be applied to the top part of the test assembly through a rubber block of a diameter at least 1 inch (25 mm) less than the outside diameter of the light assembly. The rubber block shall be 1 inch (25 mm) thick and have a Shore A hardness of 55-70. For inpavement light fixtures, the total load (in pounds) to be applied shall be 450 times the area (square inches) of the light fixture. For base plates, the load shall be 2500 pounds (1125 kg). The load shall be applied uniformly over the rubber at a rate not greater than 10,000 pounds (4,535 kg) per minute; full load shall be applied for at least 1 minute. The test fixture shall be considered unsatisfactory if there is any permanent deformation; cracking of material or finish; breaking; or damage to any part of the light, base assembly, or base plate.

4.5 Inpavement Light Fixture Testing. Unless otherwise noted, the inpavement light fixtures shall be tested under simulated installed conditions. Class 2 lights shall be tested while attached to an L-868 base or facsimile. Class 1 lights shall be tested with any shallow base or other accessories used for installation.

4.5.1 Mechanical Tests.

4.5.1.1 Vibration Test. The light fixtures shall be subjected to a sinusoidal vibration along three mutually perpendicular axes (parallel to the centerline, perpendicular to the centerline, and vertically). The test shall be conducted in two parts; the second part is only necessary if the lamp is damaged during the first part. For the initial test, the lamp shall be shunted, and the continuity continuously monitored. The fixture shall be vibrated over a frequency range of 20 to 500 Hz, with a maximum acceleration of 10 Gs. The fixture shall then be vibrated from 500 to 2000 Hz, with a maximum acceleration of 15 Gs. The duration of each sweep shall be 10 minutes. After vibrating, the light fixture shall be inspected. Mechanical failure of any component, loosening of any part or fastener, loss of continuity during testing, or any discernible movement of lamps in lampholders during the test shall be cause for rejection. If the lamp is damaged, it shall be replaced, the shunt removed, and the test rerun, with the maximum G loading being 3 Gs. After performance of the second test, breakage of the lamp filament and/or envelope shall be cause for rejection.

4.5.1.2 Shock Test. For type L-850 light fixtures, the assembled unit shall be mounted rigidly on either a 1-inch thick (25 mm) steel plate or a 4-inch (100 mm) or more thick concrete base. The dimensions of the steel or concrete base shall be at least 3x3 feet (1x1 m). The light fixture shall be turned on at full brightness for at least 2 hours prior to starting the test. With the light still on at full brightness, a case hardened steel ball weighing 5 pounds (2.27 kg) shall be dropped on the center of the top of the light fixture from a height of 6 feet (1.83 m), 10 times with a 5-minute interval between each drop. Upon conclusion, the light fixture shall be opened to determine if the optical assembly has been damaged or any component displaced.

4.5.1.3 Horizontal Shear Test. This test is to simulate the shearing load applied to the top of any inpavement fixture by a braking aircraft tire. A bar shall be attached (welded) to the top of the fixture so it is parallel to the runway centerline when the light is installed. The ends of the bar should extend beyond the edges of the fixture to facilitate loading. The light fixture, attached to a base receptacle or facsimile and torqued to manufacturer's specifications, shall be installed in a press with the attached bar in line with the piston of the press. A load of 3,000 pounds (1360 kg) shall be applied to the end of the bar by the press. The load shall be applied and released 20 times to each end of the bar. Any structural damage, movement of any part, or loosening of fasteners shall be cause for rejection.

4.5.2 Thermal Tests.

4.5.2.1 Low Temperature Test. The light shall be totally immersed in water. While immersed, the fixture shall be subjected to a low temperature of -55 $\pm 2^{\circ}$ C for a period of 24 hours. The cold soak shall be followed immediately by operation at rated current for 30 minutes or until free from ice, whichever comes first. This shall be repeated for a total of three cycles. Any evidence of damage shall be cause for rejection.

4.5.2.2 Cycling and Thermal Shock Test. The light fixture shall be subjected to an on-off cycling test by operating the unit at rated current at room temperature (dry) for a period of not less than 4 hours. The fixture shall then be de-energized and immediately submerged under at least 1 foot (300 mm) of water for at least 4 hours. The temperature of the water before submersion shall be 5° C or lower. This cycle shall be repeated a total of three times, and the fixture shall be immediately inspected at the completion of the third cycle. Any evidence of glass breakage or lens damage; any leakage of water into the optical assembly; or damage to any part of the fixture shall be cause for rejection.

4.5.2.3 Surface Temperature Test. Tests shall be conducted to demonstrate that the maximum temperature on top of the inset light does not exceed 160° C, when the light is covered with the tire of a heavy ground vehicle of at least 6,000 pounds (2720 kg) GVW rating for a period of 10 minutes. Before this 10-minute test period, the light unit shall be operated at high intensity for at least 2 hours in still air whose ambient temperature is at least 25° C. The fixture shall use the lowest transmissivity filter to be qualified. The thermocouple shall be located between the hottest point of the fixture and the tire to register the test temperature.

4.5.3 Water Tests.

4.5.3.1 Hydraulic Impact Test. For type L-850 light fixtures, the light assembly shall be submerged in water to a depth of approximately 1/2 inch (13 mm). The upper surfaces of the light fixture around the windows shall be encased in a leak-proof metal housing with a 1-3/4 inch (45 mm) diameter steel piston. The chamber shall be filled with water and purged of all air. A 5-pound (2.27 kg) steel ball shall be dropped 6 feet (1.83 m) onto the piston. The light must not be damaged after this test has been repeated five times.

4.5.3.2 Leakage Test. This test shall be performed after the assembled light unit has successfully passed the vibration test, impact test, hydraulic impact test, and load test. Prior to performing this test, the wire leads shall be subjected to a 30-pound (13.6 kg) tension for 5 minutes to test the integrity of the seal where the leads enter the fixture. The entire assembly shall then be submerged in water at least 3 inches (80 mm) below the surface and subjected to an internal air pressure of 20 psi (138 kPa) and maintained for a period of 10 minutes. Any leakage shall be cause for rejection. Leakage tests on production units may use this method, a freon leak detector, or other approved method to ensure that the optical assembly is watertight.

4.5.4. Accelerated Life Test. An accelerated life test shall be performed on inpavement light fixtures. The light fixture shall be set in dry sand at a stabilized temperature of at least +55° C, simulating its installation in pavement. The sand shall be at least 5 inches thick around the sides and bottom of the light assembly. The sand shall fill any openings in the light assembly which would be below pavement level. The unit shall then be operated for at least one-half the rated lamp life at rated current. Light units being supplied with filters should have the lowest transmissivity filter in place during this test. After this, all sand shall be removed and the photometric performance of the unit shall be measured as described in 4.3. Intensities shall not be less than 80 percent of the intensities specified in the appropriate table. After this test, the light assembly shall be taken apart and thoroughly examined. Any deformation, blistering, evidence of heat damage, or corrosion shall be cause for rejection.

4.5.5 Insulation Resistance Check. The fixtures shall be subjected to a 500-volt insulation resistance test (lead to case). The initial resistance shall be at least 50 megohms. The light assembly complete with base receptacle shall then be operated for 1 hour at rated current and shall be immediately submerged in a saturated salt water solution except for the ends of the leads. The resistance test shall be repeated. Resistance shall be at least 50 megohms.

4.5.6 Protective Plating Test. Zinc plating shall be tested by the appropriate method described in ASTM B-633; cadmium plating shall be tested by the appropriate method described in Federal Specification QQ-P-416.

4.6 Elevated Light Tests.

4.6.1 High Temperature Test. A high temperature test shall be conducted in accordance with MIL-STD-810, Method 501.2, Procedure II. The equipment shall be subjected to 3 cycles according to table 501.2-I, except that the temperature shall be adjusted upward so that the maximum is 55° C. The fixture shall be installed in a normal operating configuration, and shall be operated throughout the test. Any deterioration in the materials or performance shall be cause for rejection. This test shall be run with the highest wattage lamp and lowest transmissivity filter to be qualified. A separate test shall be run to demonstrate the performance of any nonmetallic yield device at high temperature.

4.6.2 Low Temperature Test. A low temperature test shall be conducted in accordance with MIL-STD-810, Method 502.2, Procedure II. The system shall be subjected to a 24 hour soak at -55° C, and shall be operated at the beginning and end of the soak period. Any deterioration in materials or performance shall be cause for rejection. A separate test shall be run to demonstrate the performance of any "pop-out" or nonmetallic yield device at low temperature.

4.6.3 Rain Test. A rain test shall be conducted in accordance with MIL-STD-810, Method 506.2, Procedure I, with a rain rate of 5.2 inches/h (13 cm/h). The test duration shall be 30 minutes per side. Any leakage of water into the lamp body shall be cause for rejection.

4.6.4 Salt Fog Test. If the fixture has external metal components, a salt fog test shall be conducted on the assembled light fixture in accordance with MIL-STD-810, Method 509.2. Any evidence of damage, rust, pitting, or corrosion shall be cause for rejection.

4.6.5 Yield Device. The manufacturer shall furnish test reports showing that the yield device meets the requirements of 3.4.2.1. All tests shall be performed with the light unit fully assembled at nominal height (14 inches or 350 mm) and mounted to a rigidly secured base plate. The load shall be applied to the body at a point just below the lens, no faster than 50 pounds (220 N) per minute until the minimum bending moment of 3.4.2.1 is achieved. After it has been determined that the light unit will sustain this load without damage, the loading shall continue at the same rate until yielding at the yield point occurs. For "pop-out" or other friction-type devices, the test shall be repeated 10 times on the same device to check for loosening of the attachment. The test shall be repeated on a total of five frangible fittings. Tests for nonmetallic yield devices shall also be conducted at -55° C and +55° C ($\pm$15°). Failure of any of the devices to meet the requirements

of 3.4.2.1 or damage to any part of the light unit before the yield device gives shall be cause for rejection. For friction type devices, the manufacturer shall provide data on how many "pop-outs" may be expected before the device falls below the minimum yield value.

4.6.6 Solar Radiation Test. A sunshine test shall be conducted in accordance with MIL-STD-810, Method 505.2, Procedure II for all light fixtures with nonmetallic exterior parts. The material shall be subjected to a minimum of 56 cycles. At the conclusion of the test, any evidence of deterioration or alteration of the light fixture shall be cause for rejection. For plastic optical lenses or covers, the photometric performance shall be measured after this test. Certification from the plastic manufacturer that the material has previously passed this test may be provided in lieu of performing the test.

4.6.7 Wind Test. The manufacturer shall demonstrate (by wind test or static loading) that, when subjected to the wind requirements in 3.2, no part of the light, mounting system, or yield device is damaged, and the light does not sway more than 1 inch (25 mm). If a light for snow areas is offered (3.4.2), it shall also be wind tested.

4.6.8 Certification. The manufacturer shall furnish a certification from the lamp manufacturer that the proposed lamp will meet the lamp life requirements. Evidence shall be submitted that the lens conforms with the requirements of 3.8.

4.6.9 L-804 Operational Test. An operational test shall be conducted on the L-804 to demonstrate flash rate, flash duration, intensity control, vertical adjustment, and any other required operational features.

4.7 Production Testing. A sampling of the inpavement lights, defined by MIL-STD-105, Inspection Level II, AQL 2.5, shall be subjected to photometric and leakage tests. In the photometric tests, the fixture shall meet the intensity distribution requirements in the appropriate column of Table 1. If abbreviated photometric test methods are used for production testing, these methods must have prior approval of the FAA's Office of Airport Standards. The optical assembly shall be pressurized internally to 20 psi (138 kPa) and tested for leaks. These tests are subject to inspection by a Government representative.

5. METRIC UNITS. To promote an orderly transition to metric units, this specification includes both English and metric dimensions. The metric conversions may not be exact equivalents and until there is an official changeover to the metric system the English dimensions will govern.

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